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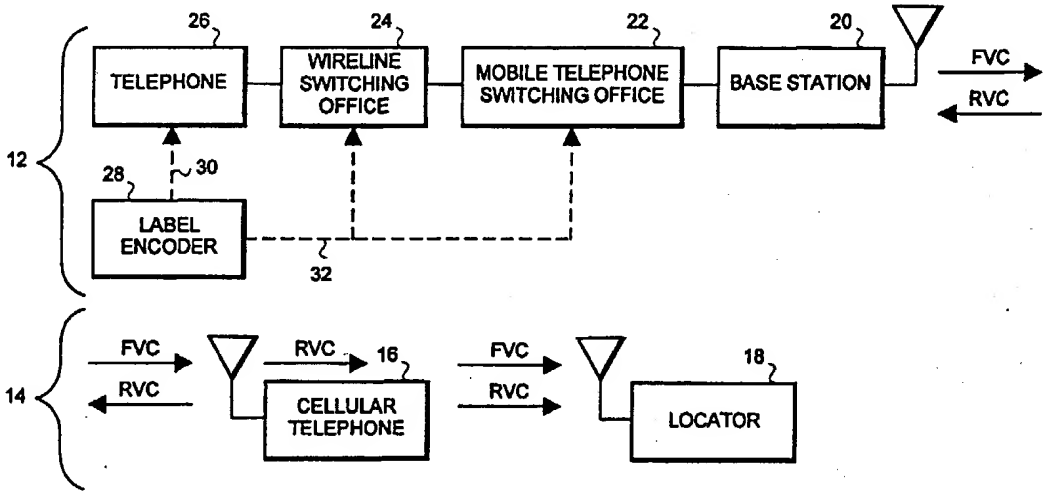

(57) Abstract

A cell phones location system and method includes mixing an identifiable audio signal (28) with the voice signal transmitted on the forward voice channel of the cell phone (16) in use, scanning (18) cell phone forward voice channels for the purpose of determining a voice channel allocation for the cell phone (16) in use by identifying the mixed audio signal, and locating (18) the operating cell phone (16) in response to a reverse voice channel signal from the cell phone (16) which reverse voice channel corresponds to the determined forward voice channel allocation.

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APPARATUS AND METHOD FOR LOCATING CELLULAR TELEPHONES WHILE IN USE

Background of the Invention

Related Applications

This application is a continuation-in-part of application serial number 08/492,821, filed June 20, 1995.

Field of the Invention

The present invention generally relates to locating cellular telephones, and particularly to the locating of such phones while in use.

Statement of the Prior Art

A great deal of interest has developed in the ability to locate cellular telephones or, cell phones, when they are either operating or at least turned on. One of the needs for such a function is in the area of emergency or 911 calls. Many such calls are placed using cell phones by people who do not know where they are located. Even when such people have a general idea of their location, minor confusion or inaccuracy can be sufficient to significantly delay the arrival of assistance. It is a known technique for 911 operators to listen over an emergency call for the approach of sirens and to direct response vehicles accordingly. Federal regulation could require cellular service providers to supply location data for cellular 911 calls.

Various systems are being considered by cell phone service providers to determine the location of cell phones for this and other purposes. Such systems typically include equipment which requires installation at all cell phone base stations and uses either time-difference-of-arrival or direction-of-arrival techniques to locate cell phones after collecting cell phone transmission data from two or more cell sites. This equipment is an expensive acquisition for cell phone service providers. Such systems are further inherently limited by the limited transmission power and the resulting transmission range of cellular phones.

Summary of the Invention

Accordingly, it is an object of the present invention to provide an apparatus and method for locating operating cell phones being used to request emergency assistance.

It is a further object of the present invention to provide such a locating function without requiring either the acquisition of expensive locating equipment by cell phone service providers or the direct involvement of their employees in location operations.

It is a still further object of the present invention to provide such a locating function at effective distances from the operating cell phone, which distances are greater than the transmission range of a typical cell phone.

In one embodiment, the present invention provides a method for locating cellular telephones, or cell phones, while in use receiving and transmitting signals over paired forward and reverse voice channels, respectively, comprising the steps of mixing an identifiable signal with the signal transmitted on the forward voice channel of the cell phone in use, scanning cell phone forward voice channels for the purpose of determining a voice channel allocation for the cell phone in use by identifying the mixed identifiable signal, and locating the operating cell phone in response to a reverse voice channel signal from the cell phone which reverse voice channel is paired to the determined forward voice channel allocation. In a refinement of this method, the step of locating the operating cell phone includes first deterimining a general location of a base station which is transmitting the forward voice channel signal and then locating the operating cell phone in response to the reverse voice channel signal of the cell phone from the determined general location of the base station.

In another embodiment, the present invention provides an apparatus for locating cellular telephones, or cell phones, while in use receiving and transmitting signals over paired forward and reverse voice channels, respectively, comprising: means for mixing an identifiable signal with the signal transmitted on the forward voice channel of the cell phone in use; and means for locating a cell phone in use based upon received transmission signals including means for scanning cell phone forward voice channels for the purpose of determining a voice channel allocation for the cell phone in use by identifying the mixed identifiable signal, and means for locating the operating cell phone in response to a reverse voice channel signal from the cell phone which reverse voice channel corresponds to the determined forward voice channel allocation. In a refinement of this apparatus the means for locating the operating cell phone includes means for first deterimining a general location of a base station which is transmitting the forward voice channel signal and then locating the operating cell

phone in response to the reverse voice channel signal of the cell phone from the determined general location of the base station.

Brief Description of the Drawings

The present invention is illustratively described in reference to the appended drawings in which:

Fig. 1 is a representational system schematic of a cell phone location system constructed in accordance with one embodiment of the present invention; and

Fig. 2 is a schematic of locating methodology practicable with the embodiment of Fig. 1.

Detailed Description of the Drawings

Fig. 1 shows a cell phone location system generally including a wireline portion 12 and a wireless portion 14. Wireless portion 14 includes an operating cell phone 16 and a cell phone locator 18. Wireline portion 12 includes a base station 20, a mobile telephone switching office 22, a wireline telephone switching office 24, an ordinary wireline telephone 26 and an audio label encoder 28. Telephone 26 is engaged in a call with cell phone 16 via the wireline switching office 24, mobile switching office 22 and base station 20.

Label encoder 28 is used to generate an audio signal which is mixed with the audio signal of the wireline phone 26. This mixing may occur either at the phone 26, or at the wireline switching office 24, or at the wireless switching office 22. For the application of emergency calls, such as 911, label encoder 28 may readily be connected at the emergency operators phone, as shown by dotted line 30. In this manner, no other interface is required with either the wireline or wireless operating systems. For the application of surreptitiously locating individuals using cell phones through the use of court ordered wiretaps, either the wireline or wireless service providers may mix the audio signal from encoder 28 with the identified call, as represented by dotted line 32.

In either of the above two applications, and particularly in respect to the latter, the audio signal mixed with the voice channel may be a spread spectrum signal which either does not interfere with the ongoing conversation or which cannot even be detected by the callers. To further avoid alerting the callers, the audio signal can be mixed only with voiced intervals of the conversation.

Although the present embodiment teaches the use of an audio signal as a label on the transmission signal, it is also possible to use a digital data label. Cell phone systems imbed digital control data in the transmitted voice signals for controlling certain parameters of the cell phone, such as the channel allocation. this control data could include a unique signal which could be decoded and identified.

Regardless of whether an audio signal or digital signal is used as the identifiable label, the signal used may be unique to allow distinction thereof from other such labels that might be in simultaneous local use.

The voice signal from phone 26 along with the mixed audio signal is transmitted by base station 20 to cell phone 16 as well as throughout the general area of location of cell phone 16. Thus, this mixed signal is received by an addition receiver 18, which is capable of scanning all of the cell phone forward voice channels and identifying the specific forward channel, FVC, being used by cell phone 16. This identification is made by testing each forward voice channel for the identifiable audio signal mixed into the specific call. The encoded label may likewise be located and the forward voice channel identified if the label is embedded in the digital control data of the forward voice channel.

The scanning and testing of forward voice channels can be performed automatically without producing or outputting other audio signals present on the channels being scanned. Thus, the tracking function can be performed without allowing eavesdropping of the phone call. Although a person in an emergency situation would necessarily consent to having their call 'tapped" by emergency personnel, the advantage thus provided is that the equipment used by emergency personnel could be rendered inoperable for use in eavesdropping. Thus, the apparatus of the present invention could be made more readily available to public service entities without fear of its illegal usage and with less regulation than is required for an eavesdropping device.

Once the specific forward voice channel is identified, receiver 18 can tune to the paired reverse voice channel simultaneously being used by cell phone 16 and locate cell phone 16 therefrom. Even if the voice channel assignment for cell phone 16 is changed in the middle of the location process, receiver 18 can just as easily rescan the forward voice channels and identify the new voice channel by locating the

mixed audio signal. Likewise locator 18 could be monitoring the control data on the forward voice channel and have some anticipation of the switch in channels.

Fig. 2 demonstrates a situation in which the cell phone locator 18 is beyond the transmission range of the cell phone 16 to be located. The locator 18 is within range of the base station 20 and thus receives the forward voice channel, FVC, therefrom. Cell phone locator 18 may even be separated from base station 20 by much more than normal cell phone transmission range. The reason is that cell phone base stations typically transmit at a higher power than cell phones and are typically well positioned geographically to enhance their transmission range. By way of example, where the range of an ordinary cell phone transmission might be five or six miles, the range at which locator 18 can receive a base station transmission can be greater than twenty miles.

Reception of the FVC allows the locator 18 to identify the forward and reverse voice channels of the emergency call in progress however, tuning to the paired reverse voice channel may not provide a signal for tracking. In this situation, cell phone locator 18 can track the forward voice channel and first locate the base station 20 which is handling the emergency call. Location of base station 20 is again done without interfacing with the cell phone system or any of its personnel.

Once cell phone locator 18 is in the general location of base station 20, it will come within the transmission range of cell phone 16, thus allowing reception of the reverse voice channel by locator 18. Once reception of the reverse voice channel is established, direct tracking of the cell phone can commence.

Any suitable technology may be used in accordance with the present invention to locate an operating cell phone such as the MICRO LOOK Cell Phone Locator described in the US Patent Application entitled APPARATUS AND METHOD FOR FINDING A SIGNAL EMISSION SOURCE, by David L. Herrick, et al., serial number 08/272,724, filed July 9, 1994, the contents of which are hereby incorporated by reference herein. Such a suitable locator would typically provide the direction of arrival of the received signals, in this case, both the forward and reverce voice channel signals. From that information, locator 18 can be moved, by vehicle or otherwise, towards the transmission source, whether base station 20 or cell phone 16, until that source is located. The device cited above uses movement of the device

along with carrier signal phase measurements to indicate the direction of arrival of the transmission signals.

Conclusion

Implementation of the present invention is much less expensive and a great deal more accurate than systems requiring installation at each cellular base station. Further no interface with cellular facilities is required. For this reason, the present invention is readily compatible with all existing cellular installations. Lastly, the system can operate over ranges which are much greater than the usual cell phone transmission ranges.

The embodiments described above are intended to be taken in an illustrative and not a limiting sense. Various modifications and changes may be made to the above embodiments by persons skilled in the art without departing from the scope of the present invention as defined in the appended claims. The present invention is not restricted to cellular telephones and may be applied to any wireless communication device which transmits signals on paired channels in separate directions. Embodiments of the present invention may also be used as part of a theft recovery system for objects large enough to conceal a cell phone, i.e. automobile, by activating a concealed cell phone with a silent theft alarm.

WHAT IS CLAIMED IS:

1. A method for locating cellular telephones, or cell phones, while in use receiving and transmitting signals over paired forward and reverse voice channels, respectively, comprising the steps of:

mixing an identifiable signal with the signal transmitted on the forward voice channel of the cell phone in use;

scanning cell phone forward voice channels for the purpose of determining a voice channel allocation for the cell phone in use by identifying the mixed identifiable signal, and

locating the operating cell phone in response to a reverse voice channel signal from the cell phone which reverse voice channel is paired to the determined forward voice channel allocation.

2. The method of claim 1, wherein the step of mixing is performed at the location of an emergency operator.

3. The method of claim 1, wherein the identifiable signal is an audio signal and is mixed with the voice signal transmitted on the forward voice channel.

4. The method of claim 1, wherein the identifiable signal is unique for differentiating from other simultaneous cell phone calls undergoing the same location procedure.

5. The method of claim 1, wherein the identifiable signal is a spread spectrum signal.

6. The method of claim 1, wherein the identifiable signal is mixed with voiced portions of the forward voice channel signal.

7. The method of claim 1, wherein the identifiable signal is mixed with control data portions of the forward voice channel signal.

8. The method of claim 1, wherein the step of locating the operating cell phone includes first deterimining a general location of a base station which is transmitting the forward voice channel signal and then locating the operating cell phone in response to the reverse voice channel signal of the cell phone from the determined general location of the base station.

9. The method of claim 1, wherein the step of locating the operating cell phone includes determining the direction of arrival of the reverse voice channel signal.

10. An apparatus for locating cellular telephones, or cell phones, while in use receiving and transmitting signals over paired forward and reverse voice channels, respectively, comprising:

means for mixing an identifiable signal with the signal transmitted on the forward voice channel of the cell phone in use; and

means for locating a cell phone in use based upon received transmission signals including

means for scanning cell phone forward voice channels for the purpose of determining a voice channel allocation for the cell phone in use by identifying the mixed identifiable signal, and

means for locating the operating cell phone in response to a reverse voice channel signal from the cell phone which reverse voice channel corresponds to the determined forward voice channel allocation.

11. The apparatus of claim 10, wherein the means for mixing is located with an emergency operator.

12. The apparatus of claim 10, wherein the means for mixing is adapted to produce an audio signal and mix it with a coice signal transmitted on the forward voice channel.

13. The apparatus of claim 10, wherein the means for mixing is adapted to produce an identifiable signal which is unique for differentiating from other simultaneous cell phone calls undergoing the same location procedures.

14. The apparatus of claim 10, wherein the identifiable signal is a spread spectrum signal.

15. The apparatus of claim 10, wherein the means for locating the operating cell phone includes means for determining the direction of arrival of received voice channel signals.

16. The apparatus of claim 10, wherein the means for locating the operating cell phone includes means for first deterimining a general location of a base station which is transmitting the forward voice channel signal and then locating the operating cell phone in response to the reverse voice channel signal of the cell phone from the determined general location of the base station

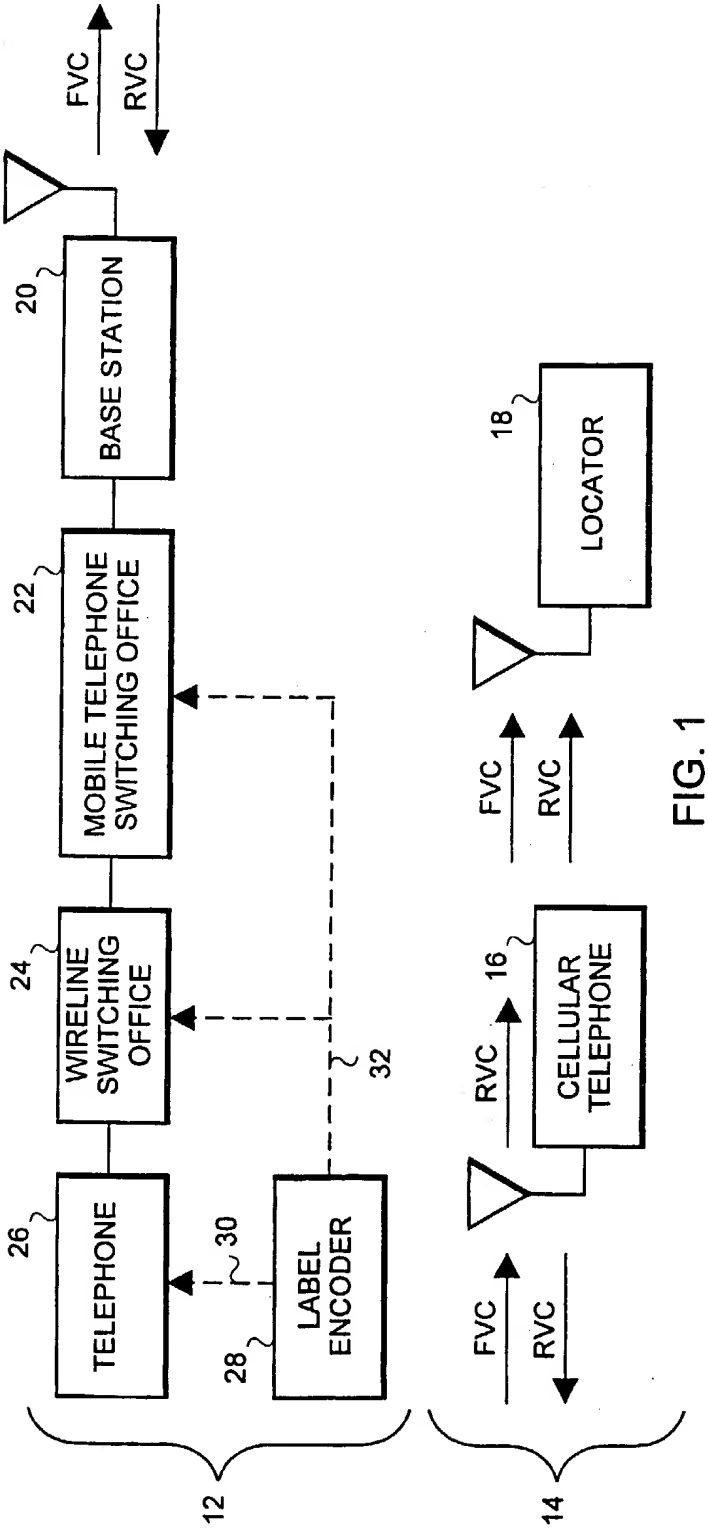
FVC
RVC
20
BASE STATION
22
MOBILE TELEPHONE SWITCHING OFFICE
24
WIRELINE SWITCHING OFFICE
26
TELEPHONE
30
28
LABEL ENCODER
32
12
18
LOCATOR
FVC
RVC
16
CELLULAR TELEPHONE
RVC
FVC
RVC
14

FIG. 1

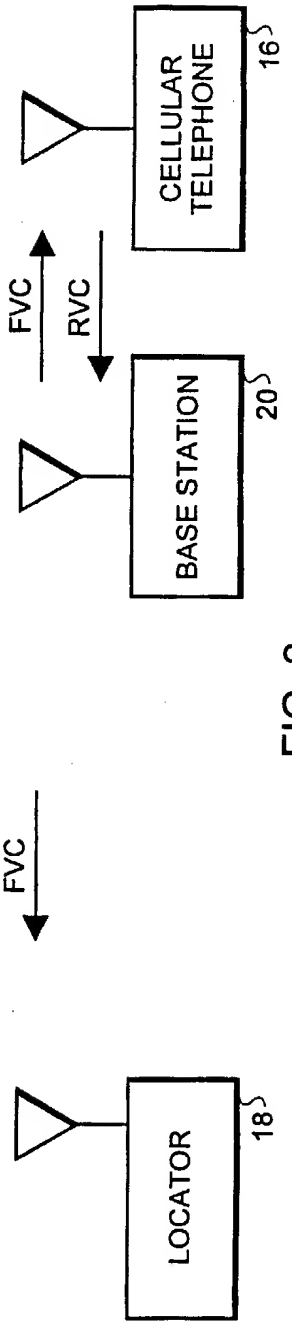
CELLULAR TELEPHONE
16
FVC
RVC
BASE STATION
20
FVC
LOCATOR
18

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/10629

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04B 7/28, 17/00; H04Q 7/22
US CL :455/33.1, 54.1, 67.1; 379/59
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/33.1, 34.1, 34.2, 54.1, 54.2, 38.2, 38.5, 67.1; 379/58, 59, 63; 342/386, 457

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 5,247,698 (Sawyer et al) 21 September 1993, see abstract.	1-16
A	US, A, 5,343,493 (Karimullah) 30 August 1994, see abstract	1-16
A	US, A, 5,479,482 (Grimes) 26 December 1995, see abstract.	1-16
A,P	US, A, 5,512,908 (Herrick) 30 April 1996, see abstract.	1-16

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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